AMENDMENTS TO THE CLAIMS:

This listing of claims will replace all prior versions, and listings, of claims in the application:

LISTING OF CLAIMS:

1. (Currently Amended) A method of perceptual 3-dimensional (3D) shape description, the method comprising:

generating nodes that respectively correspond to parts of a part-based representation of a 3D shape model, the nodes including unary attributes of the parts, wherein the unary attributes of the nodes comprise at least a volume, eccentricities, and a convexity;

generating edges that include relational attributes between the nodes; and

generating an attributed relational graph of the 3D shape model that is comprised of the nodes and the edges.

2. (Original) The method of claim 1, wherein each of the nodes is represented by an ellipsoid parameterized by a volume, a convexity, and eccentricities.

3. (Cancelled)

4. (Original) The method of claim 1, wherein the unary attributes of each of the nodes comprise variances that correspond to the degrees of distribution of

voxels approximated by the ellipsoid on 3D principal axes, the origin of the ellipsoid, and the transformation of the node in an object-oriented coordinated system.

5. (Original) The method of claim 1, wherein the relational attributes comprise at least the distance between the centers of the ellipsoids, the angle between the first principal axes of ellipsoids, and the angle between the second principal axes of the ellipsoids.

6. (Original) The method of claim 1, wherein the unary attributes of the nodes are quantized by a predetermined number of bits.

7. (Currently Amended) A computer readable ~~medium~~ memory having a perceptual 3-dimensional (3D) shape descriptor formed by the method according to claim 1.

8. (Original) A method of searching a database of 3-dimensional (3D) graphics models described by the method of claim 1, the method comprising:

receiving a query 3D graphics model;

transforming the received 3D graphics model into a perceptual 3D shape descriptor; and

comparing the perceptual 3D shape descriptor with each of the perceptual 3D shape descriptors of the 3D graphics models stored in the database to retrieve the 3D graphic models that are similar to the perceptual 3D shape descriptor.

9. (Original) The method of claim 8, wherein the receiving of the query 3D graphics model comprises a user designing and inputting a 3D graphics model by means of an interactive tool.

10. (Original) The method of claim 8, wherein the transforming of the received 3D graphic models into the perceptual 3D shape descriptor comprises a user editing the transformed 3D shape descriptor if required.

11. (Original) The method of claim 8, wherein the comparing of the perceptual 3D shape descriptor with each of the perceptual 3D shape descriptors of the 3D graphics models to retrieve the 3D graphic model comprises:

defining the volumes of the nodes as weights; and

comparing the transformed perceptual 3D shape descriptor with each of the perceptual 3D shape descriptors of the 3D graphics models stored in the database using a double earth mover's distance method to retrieve the 3D graphic models similar to the perceptual 3D shape descriptor,

wherein the double earth mover's distance method comprises:

generating a distance matrix between query nodes of a query graph and model nodes of a model graph; and

measuring the similarity between the query graph and the model graph by calculating the amount of work required to move the weight from the query nodes to the model nodes based on the distance matrix.

12. (Original) The method of claim 11, wherein the generating of the distance matrix comprises:

extracting the query nodes of the query graph of the perceptual 3D shape descriptor and the model nodes of the model graph of each of the 3D graphics models stored in the database and setting combinations of the query and model nodes to be compared with each other; and

generating the distance matrix by measuring the distance between the query and model nodes of each of the combinations.

13. (Original) The method of claim 12, wherein the generating of the distance matrix by measuring the distance between the query and model nodes of each of the combinations comprises:

constructing a first distance matrix of the absolute values of differences between attribute vectors of the query and model nodes to calculate the distance between the query and model nodes of each of the combinations;

constructing vector spaces with axes parameterized by relational attributes of the nodes;

expressing the query nodes and the model nodes as sets of points in the respective vector spaces;

setting an imaginary node in each of the vector spaces, the imaginary node being spaced an equal distance apart from all of the points;

constructing a second distance matrix by calculating the Euclidian distances between the points in the vector spaces; and

summing the first and second distance matrices to generate the distance matrix.

14. (Original) The method of claim 11, wherein the measuring of the similarity between the query graph and the model graph comprises:

calculating the amount of work required to move the weight from the query nodes to the model nodes based on the distance matrix and the weights of the query nodes of the query graph and the model nodes of the model graphs; and

calculating as the similarity a total amount of work for all of the nodes.

15. (Currently Amended) A computer readable ~~medium~~ memory having embodied thereon a computer program for the method according to ~~any one of~~ claim 8.

16. (Currently Amended) An apparatus for searching a database of 3-dimensional (3D) graphics models that included nodes that respectively correspond to parts of a parts-based representation of a 3D shape model, the nodes including unary attributes of the parts, wherein the unary attributes of the nodes comprise at least a volume, eccentricities, and a convexity; and edges that include relational attributes between the nodes ~~described by the method of claim 1~~, the apparatus comprising:

a query input unit that receives a query that is a 3D graphics model;

a model/shape descriptor transforming unit that transforms the 3D graphic model received as the query into a perceptual 3D shape descriptor;

a matching unit that compares the perceptual 3D shape descriptor with each of the perceptual 3D shape descriptors of the 3D graphics models stored in the database to retrieve the models that are similar to the perceptual 3D shape descriptor; and

a model output unit that outputs the retrieved model.

17. (Original) The apparatus of claim 16, wherein the query input unit allows a user to design and input the 3D graphics model by means of an interactive tool.

18. (Original) The apparatus of claim 16, wherein the model/shape descriptor transforming unit comprises a shape editor that allows a user to edit the perceptual 3D shape descriptor if required.

19. (Original) The apparatus of claim 16, wherein the matching unit comprises:

a weight converter that defines the weights of the nodes as weights; and

a model searcher that compares the perceptual 3D shape descriptor with each of the perceptual 3D shape descriptors of the 3D graphics models stored in the database using a double earth mover's distance method to retrieve the models from the database that are similar to the perceptual 3D shape descriptor,

wherein the double earth mover's distance method comprises:

generating a distance matrix between query nodes of a query graph and model nodes of a model graph; and

measuring the similarity between the query graph and the model graph by calculating the amount of work required to transform the query graph to the model graph based on the distance matrix.

20. (Original) The apparatus of claim 19, wherein the generating of the distance matrix comprises:

extracting the query nodes of the query graph of the perceptual 3D shape descriptor and the model nodes of the model graph of each of the perceptual 3D shape descriptors of the 3D graphics models stored in the database to set combinations of the query and model nodes to be compared with each other; and

constructing a first distance matrix of the absolute values of differences between attribute vectors of the query and model nodes to calculate the distance between the query and model nodes of each of the combinations;

constructing vector spaces with axes parameterized by relational attributes of the nodes;

expressing the query nodes and the model nodes as sets of points in the respective vector spaces;

setting an imaginary node in each of the vector spaces, the imaginary node being spaced an equal distance apart from all of the points;

constructing a second distance matrix by calculating the Euclidian distances between the points in the vector spaces; and

combining the first and second distance matrices to generate the distance matrix, and

the measuring of the similarity between the query graph and the model graph comprises:

calculating the amount of work required to transform the query graph to the model graph for each of the nodes based on the distance matrix and the weights of the query nodes of the query graph and the model nodes of the model graphs; and

calculating as the similarity a total amount of work for all of the nodes.